

A THIN MAGNETIC FILM SHIFT REGISTER

BY

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A Thin Magnetic Film Shift Register*

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Summary—An initial application of the dynamics and interactions of domains within continuous magnetic thin film structures is made to a shift register in which binary information is stored and translated in and along a continuous evaporated thin magnetic film. These thin magnetic film shift registers are capable of storing information having a density of several hundred bits per square inch of vacuum evaporated structure and of translating this amount of information at bit rates in excess of a megacycle with powers of less than 10 watts.

INTRODUCTION

THE dynamics and interactions of domains¹ within continuous magnetic thin film structures may be applied to a variety of information processing or computing functions. A useful initial application of this concept is to a shift register in which binary information is stored and translated in and along a continuous evaporated thin magnetic film. This operation may be pictured as analogous to a magnetic drum surface on which the "bits" move instead of the drum. The basic simplicity of continuous shifting systems which eliminate the usual cell to cell coupling networks makes such an approach extremely attractive. Magnetic shifting involving continuous wire structures has been reported.² In the film system to be described, the very-high-volume density of stored information, the low power of operation, the relatively high speed of operation, and the automated production potential indicate unusual system possibilities.

THEORETICAL CONSIDERATIONS

The operation of this device can be explained, in a preliminary way, on the basis of a difference which can be made to exist between the energy required to establish or create a particular domain configuration within the magnetic continuum, and the energy required to translate the given domain configuration a distance through the continuum. This difference allows "written" domains to be moved unilaterally under the influence of periodically pumped forcing fields without these fields introducing any spurious information.

The specified energy difference may be inferred from the following considerations. The creation energy for establishing a given domain configuration within a mag-

netic continuum contains conservative terms such as the magnetostatic, magnetocrystalline, and exchange energies, as well as the dissipative terms associated with switching the magnetic material. The translation energy for moving a given domain contains only a dissipative energy term, with the conservative terms remaining constant (provided that the domain is translated within a uniform magnetic continuum under conditions which preserve its domain configuration and relation to its environment). Considering the control that can be exercised over these various components, a design may be selected in which it is possible to drive propagating electrodes hard enough to move domains, but not hard enough to create domains. The domain is created by a separate writing electrode and current.

A more complete consideration of the operational theory of this device must also take account of certain "rate factors," such as domain nucleation times and wall motion damping effects. These factors become increasingly important in the design of maximum speed registers.

Propagation of a domain through the magnetic film consists of translating the walls of the domain in phase to preserve the essential domain configuration. One combination of magnetic film and electrode structure for achieving this shifting action is represented in Fig. 1. Fig. 2 is an exploded view of this vacuum deposited configuration. This configuration provides means 1) for supplying the creation energy to the magnetic film through application of current to the writing electrode, 2) for supplying propagating energy to the magnetic film through application of current to the propagating electrodes, and 3) for detecting the flow of domains through the induced voltage in the readout electrode looping the magnetic film.

The configuration's operation in moving "written" domains under the influence of periodic, continuously pumped forcing fields is shown in a series of longitudinal cross sections of Fig. 3. Row 1 of Fig. 3 shows the shifting configuration with its magnetic film magnetized to the right throughout. Current is passed through the writing electrode with a direction and magnitude to reverse the magnetization of the magnetic material lying under its influence. This brings about the condition of the magnetic film shown in Row 2. Row 3 represents the translated state of the domain after current of the proper magnitude and sense has been passed through the upper propagating electrode set. The arrows indicate the alternating H field pattern set up by the flow of the current. These fields are seen to be of the proper polarity in the vicinity of the domain walls to induce

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¹D.W. Moore, "Magnetic domain switching in evaporated magnetic films" Proc. 1959 Electronic Components Conf., p. 11; May, 1959.

²A.H. Bobeck and R.F. Fischer, "Reversible diodeless twister shift register," J. Appl. Phys., vol. 30, pp. 43-44; April, 1959.

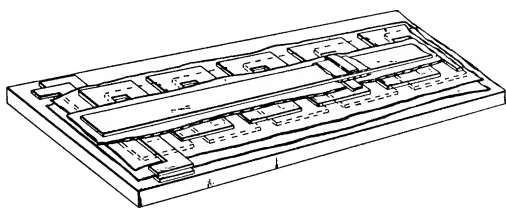


Fig. 1—Artist's sketch of the vacuum evaporated thin film shift register.

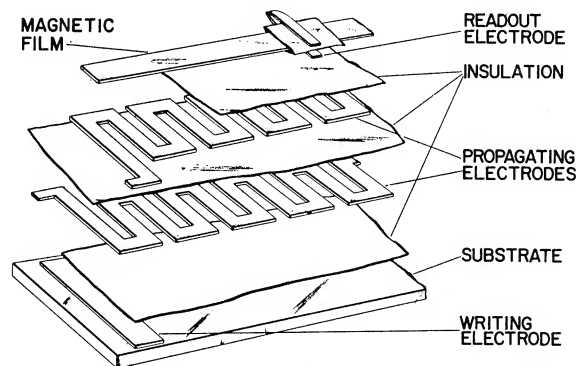


Fig. 2—Exploded view of the thin film shift register.

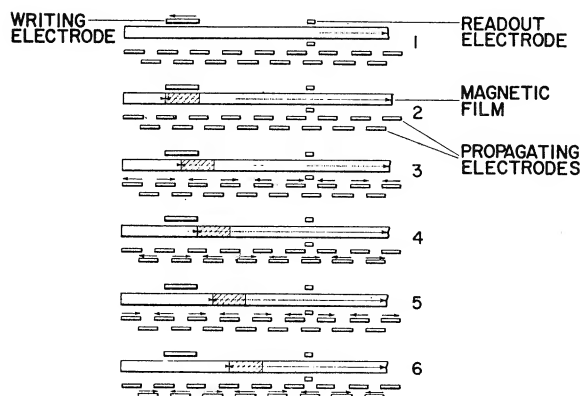


Fig. 3—A series of longitudinal cross sections demonstrating the propagating-current pattern and the shifting sequence of the register. The cross-hatched area represents a domain of reverse magnetization within the continuous magnetic film.

wall motion in the appropriate direction to translate and preserve the domain. This translation brings the domain into proper position with respect to the lower propagating electrode set. Row 4 represents the further translated state after the application of current to the lower electrode set. For the next translation, a reversed current is required through the upper propagating electrode bringing about the configuration of Row 5, and the next translation to Row 6 requires a reversed current in the lower propagating electrode. The domain is now in a position for the pattern to be repeated.

This basic four-beat propagating pattern provides the unilateral flow of domains and may be pumped continuously. Because of its subcritical field nature, the pattern is effective only in moving established domains and not in creating or establishing new domains. Obviously, the direction of information flow may be reversed

by reversing the propagating pattern. Because of the spacing and width of the information domains within a single magnetic strip, four propagation pulses are required to transport the complete bit configuration past a particular fixed reading station. A register in which information may be read at every propagating pulse time is realized by using four magnetic strips in parallel with offset READ and WRITE electrodes.

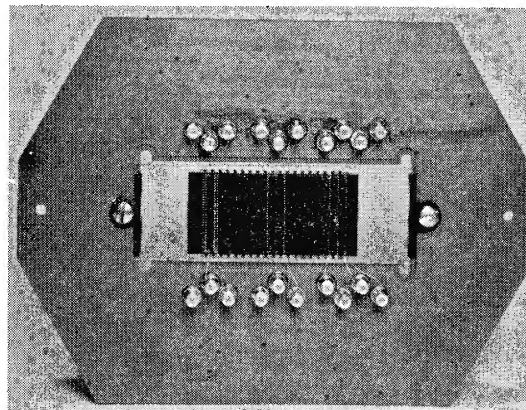


Fig. 4—A photograph of an experimental vacuum evaporated shift register. The register measures 1.5 inch $\times$ 0.9 inch.

EXPERIMENTAL REGISTERS

Fig. 4 shows an experimental thin film shift register which has been operated at propagating pulse frequencies in excess of one megacycle. This register was produced using sequential vacuum evaporation techniques³ in depositing magnetic,⁴ conducting, and insulating materials in patterns corresponding to Fig. 2. The magnetic material is deposited in an orienting magnetic field giving a preferred direction of magnetization along the length of the strip. The sequence of deposition shown in Fig. 2 was inverted, with the magnetic strips lying nearest to the substrate. The information is translated 0.020 inch during every propagating pulse, permitting 50 bits to be stored in one linear inch of the shift register. Several of these registers may easily be placed side by side in the space of one lateral inch and may be driven by a common set of propagating electrodes. In practice, this provides a surface storage density of several hundred bits per square inch.

The power required to drive a register is set primarily by the resistance of the propagating electrodes. The register of Fig. 4 requires a power of 8 watts for operation at a megacycle and 2 watts for 100-kc operation. The propagating electrode currents are 0.45 and 0.90 ampere respectively, giving H fields at the surface of the magnetic strip of 3.7 and 7.4 oersteds.

³ K. D. Broadbent, "A vacuum evaporated random access memory," *Proc. Special Tech. Conf. on Nonlinear Magnetism and Magnetic Amplifiers*, Am. Inst. Elec. Engrs., New York, N. Y., pp. 281-286; September, 1959.

⁴ M. S. Boise, Jr., "Preparation of thin magnetic films and their properties," *J. Appl. Phys.*, vol. 26, pp. 975-980; August, 1955.

Using a magnetic strip having a width of 0.040 inch, four registers (comprised of four strips each) can be placed under the propagating structure visible in Fig. 4. The pictured unit has a capacity of 300 bits. The propagating electrodes are 0.030 inch wide and spaced 0.010 inch apart, the writing electrode is 0.040 inch wide, and the readout electrodes are 0.005 inch wide. The conducting and insulating layers range from one to three microns in thickness. The magnetic strips are 900 Å thick, composed of 75 per cent nickel and 25 per cent iron, and the electrical output signals at a megacycle rate are about 1 mv in amplitude. Greater densities or larger outputs may be achieved with other designs.

The configuration of the information bit in the magnetic strip may be varied widely, depending upon the combination of geometric and material factors employed. Exceptionally high bit density registers may be operated in which the information bit is a single quasi-elliptical domain. Other registers show the bit to be a cluster of elliptical domains and still others may be operated with a semirectangular domain having a fine-structured domain boundary. Examples of these configurations are shown in Fig. 5. Photographs of the domains were obtained using the Kerr magneto-optic

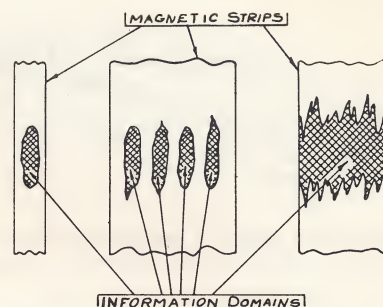


Fig. 5—Facsimiles of magneto-optic Kerr photographs showing domains within various evaporated shift register strips.

effect.⁵ This device and its operational principles are covered by a United States Patent.⁶

ACKNOWLEDGMENT

The contributions of F. J. McClung, Jr., and A. I. Braunstein to the development of this project are gratefully acknowledged.

⁵ C. A. Fowler and E. M. Fryer, "Magnetic domains by the longitudinal Kerr effect," *Phys. Rev.*, vol. 94, pp. 52-56; April 1, 1954.

⁶ K. D. Broadbent, U. S. Patent No. 2,919,432; assigned to Hughes Aircraft Co., December 29, 1959.

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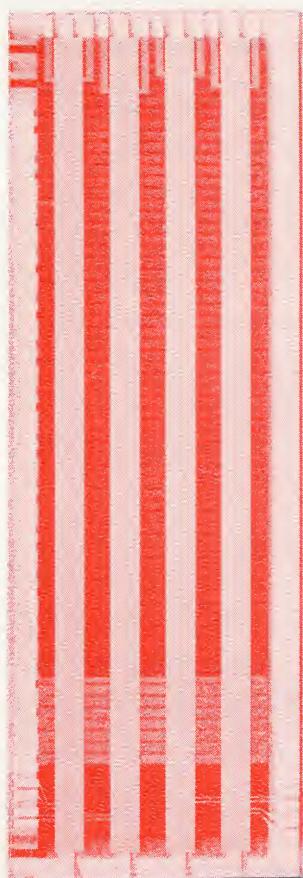
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HIGH CAPACITY, LOW COST THIN-FILM SHIFT REGISTER

Strip-Register Products



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Continuous magnetic thin-film techniques offer the opportunity of achieving simple but complete information processing systems. In the shift-register application of these techniques binary information is stored and translated in and along a continuous evaporated thin magnetic film.

The *Strip-Register* consists of vacuum-deposited magnetic strips which act as flow channels for digital information in the form of discrete magnetic domains. These magnetic strips then become flexible storage cells that can be fabricated into any desired serial/parallel, input/output configuration. This versatile unit can be tailored to your custom requirements providing a significant savings in both system and engineering costs. Our staff of Development and Application Engineers would be pleased to consider your specific custom requirements.

SRU2 – *Strip-Register* Memory Device and Electronics

The SRU2 is a high density self-contained *Strip-Register** memory and electronics on a single 4.5" by 6" plug in module. The SRU2 is an asynchronous, serial, shift register and will operate at any speed from 0 to 1,000,000 bits per second. It is a non volatile device and can be ordered in any length up to 340 bits per module. The standard voltages required to operate this unit are $\pm 10\text{Vdc}$ regulated and $\pm 18\text{Vdc}$ unregulated for biasing purposes. The SRU2 should be ordered in terms of the maximum operating frequency and number of bits desired. All of the logic, propagation and write drivers, and read amplifiers are mounted on the plug in card in small potted modules. These modules are also available separately.

SRD2 – *Strip-Register* Memory Device and Read Amplifier Only

The SRD2 is the same *Strip-Register* memory used in the SRU2 except the memory and the read amplifiers are mounted on a single 4.5" by 6" plug in module. No logic or driving electronics are provided with this unit.

SRE2 – *Strip-Register* Electronics Only

The SRE2 plug in card contains all of the logic and propagation and write drivers required to operate any standard *Strip-Register* device. It is designed to be used in conjunction with the SRD2 and provides all of the pulses and gates necessary to operate the SRD2 module.

FG-20 – Function Generator

The FG-20 Function Generator card provides a master clock (variable duty cycle) multivibrator with a frequency of from 1CPS to 1MC. It also provides a number of "test" patterns that can be fed into the *Strip-Register* memory to check its operation. The frequency of the clock can be controlled externally on the panel of the card cage if desired. Output Logic Levels: TRUE, $8\text{V} \pm 2\text{Vdc}$, FALSE, $0\text{V} + 1\text{Vdc} - \frac{1}{2}\text{Vdc}$. The rise and fall time of the output pulses have the proper characteristics to be used with any of the *Strip-Register* memory units.

*Trademark of IEC, Patented thin-magnetic film memory

CC-10 – Card Cage

The CC-10 card-cage requires only 5¼" by 19" panel space, and provides 1½" clearance behind the front panel for mounting of controls or indicators. It may be mounted so that cards plug in from the front or rear of the cage. This cage can hold up to 16 standard SRU2 *Strip-Registers*. It projects 8½" behind the front panel and is supplied less connectors and panel.

PC-10 – Powered Card Cage

The PC-10 is a powered card cage. It is supplied with a PS-12 power supply, a-c switch, fuse and pilot light on the front panel. No connectors are provided. The power supply is capable of powering two *Strip-Register* units operating at 1MC as well as their associated logic circuitry. The CC-10 card cage is used in this unit. There is 10" left in this cage for circuit cards after the power supply is mounted in one end.

PC-11 – Powered Card Cage

The PC-11 is identical to the PC-10 except it has a PS-12 power supply mounted in both ends of the card cage and is capable of powering four *Strip-Register* units operating at 1MC and their associated logic circuitry.

XC-10 – Extender Card

The XC-10 extender card provides complete access to any standard IEC card while it is electrically mounted in its circuit connection.

BC-10 – Blank Card

The BC-10 is a blank card of the standard IEC size which plugs into a 35 pin IEC connector. The card is 4½" wide by 6" long, including the pin connector.

EC-10 – Socket Connector

Mil approved card socket connector with solder tail and ½" card guides.

PS-20 – Power supply

The PS-20 plug in power supply mounts easily with four screws to any flat surface. It measures 12" long x 3" high x 4-7/8" wide. A PS-20 provides all of the power needed for two *Strip-Register* units operating at 1MC and their associated logic circuitry. Trimpots allow ±10% adjustment to the ±10Vdc voltages. Bias voltages of ± 18Vdc are also provided. An 8" input-output cable with a 15 pin connector is provided with each supply.

PS-21 – Power supply

The PS-21 is designed for rack mounting in systems using *Strip-Register* units. It provides up to 6.5 amps of each regulated voltage as well as the bias level voltages. The front panel contains a power switch and indicator. Each PS-21 supply has two d-c fuses. Dimensions 5¼" high x 12" deep.

PS-22 – Power supply

The PS-22 supply is a heavy duty regulated power supply. It provides simultaneously up to 12 amps of both ± 10 Vdc as well as 350 ma of the ± 18 Vdc bias levels. It is self-contained with an internal blower, plug in regulator card, power cord, and multiple output terminals for each voltage on rear Jones strip. Local or remote sensing may be used for the +10Vdc. The front panel contains the power switch, indicator, and ac and dc indicating fuse holders.

SRC-10A – PC-10 Wired for 1 SRU2

The SRC-10A is a PC-10 wired with an additional connector to accept one SRU2 *Strip-Register* unit. Input-output jacks for the *Strip-Register* memory using BNC connectors can be made available on the front panel, at no additional cost if requested at the time of order.

SRC-10B – PC-10 Wired for 1 SRU2 and 1 FG-20

The SRC-10B is a PC-10 wired with a connector for a FG-20 Function Generator and an additional connector to accept one SRU2 *Strip-Register* unit. A "Write Test Function" switch and "Frequency Select" switch are mounted on the front panel along with a "Fine Frequency" control and sync output jack. Input-output jacks, for the *Strip-Register* memory, using BNC connectors can be made available on the front panel, at no additional cost, if requested at the time of order.

SRC-10C – PC-10 Wired for 2 SRU2

The SRC-10C is identical to the SRC-10A except that connectors are provided for two SRU2 *Strip-Register* units. The two *Strip-Register* connectors can be connected in either series or parallel for information flow in the two registers. Unless otherwise specified at the time of order, the register connectors will be hooked up in parallel.

SRC-10D – PC-10 Wired for 2 SRU2 and 1 FG-20

The SRC-10D is identical to the SRC-10B except that connectors are provided for two SRU2 *Strip-Register* units. The two *Strip-Register* connectors can be connected in either series or parallel for information flow in the two registers. Unless otherwise specified at the time of order, the register connectors will be hooked up in parallel.

SRC-11A – PC-11 Wired for 3 SRU2

The SRC-11A is a PC-11 wired with three additional connectors to accept SRU2 *Strip-Register* units. Input-output jacks, for the *Strip-Register* memory, using BNC connectors can be made available on the front panel, at no additional cost if requested at the time of order. The three *Strip-Register* connections can be connected in any series or parallel combination desired for information flow in the three registers. Unless otherwise specified, at the time of order, the register connectors will be hooked up in parallel.

SRC-11B – PC-11 Wired for 3 SRU2 and 1 FG-20

The SRC-11B is a PC-11 wired with three additional connectors to accept SRU2 *Strip-Register* units and a connector for an FG-20 Function Generator. A "Write Test Function" switch and "Frequency Select" switch are mounted on the front panel along with a "Fine Frequency" control and sync output jack. Input-output jacks, for the *Strip-Register* memory, using BNC connectors can be made available on the front panel, at no additional cost, if requested at the time of order. The three *Strip-Register* connections can be connected in any series or parallel combination desired for information flow in the three registers. Unless otherwise specified, at the time of order, the register connectors will be hooked up in parallel.

SRC-11C – PC-11 Wired for 4 SRU2

The SRC-11C is a PC-11 wired with four additional connectors to accept SRU2 *Strip-Register* units. Input-output jacks, for the *Strip-Register* memory, using BNC connectors can be made available on the front panel, at no additional cost if requested at the time of order. The four *Strip-Register* connections can be connected in any series or parallel combination desired for information flow in the four registers. Unless otherwise specified, at the time of order, the register connectors will be hooked up in parallel.

SRC-11D – PC-11 Wired for 4 SRU2 and 1 FG-20

The SRC-11D is a PC-11 wired with four additional connectors to accept SRU2 *Strip-Register* units and a connector for an FG-20 Function Generator. A "Write Test Function" switch and "Frequency Select" switch are mounted on the front panel along with a "Fine Frequency" control and sync output jack. Input-output jacks, for the *Strip-Register* memory, using BNC connectors can be made available on the front panel, at no additional cost, if requested at the time of order. The four *Strip-Register* connections can be connected in any series or parallel combination desired for information flow in the three registers. Unless otherwise specified, at the time of order, the register connectors will be hooked up in parallel.

SRC-12A – PC-10 Wired for 1 SRE2 and 1 SRD2

SRC-12A is a PC-10 wired with an additional connector to accept one SRE2 and one SRD2 *Strip-*

Register unit. Input-output jack for the *Strip-Register* memory using BNC connectors can be made available on the front panel at no additional cost if requested at the time of order .

SRC-12B – PC-10 Wired for 1 SRE2 and 1 SRD2 and 1 FG-20

The SRC-12B is a PC-10 wired with a connector for a FG-20 Function Generator and an additional connector to accept one SRE2 and one SRD2 *Strip-Register* unit. A “Write Test Function” switch and “Frequency Select” switch are mounted on the front panel along with a “Fine Frequency” control and sync output jack. Input-output jacks, for the *Strip-Register* memory, using BNC connectors can be made available on the front panel, at no additional cost, if requested at the time of order .

SRC-12C – PC-10 Wired for 2 SRE2 and 2 SRD2

The SRC-12C is identical to the SRC-12A except that connectors are provided for two SRE2 and two SRD2 *Strip-Register* units. The Two *Strip-Register* connectors can be connected in either series or parallel for information flow in the two registers. Unless otherwise specified at the time of order, the register connectors will be hooked up in parallel.

SRC-12D – PC-10 Wired for 2 SRE2 and 2 SRD2 and 1 FG-20

The SRC-12D is identical to the SRC-12B except that connectors are provided for two SRE2 and two SRD2 *Strip-Register* units. The two *Strip-Register* connectors can be connected in either series or parallel for information flow in the two registers. Unless otherwise specified at the time of order, the register connectors will be hooked up in parallel.

SRC-13A – PC-11 Wired for 3 SRE2 and 3 SRD2

The SRC-13A is a PC-11 wired with three additional connectors to accept SRE2 and SRD2 *Strip-Register* units. Input-output jacks, for the *Strip-Register* memory, using BNC connectors can be made available on the front panel, at no additional cost if requested at the time of order. The three *Strip-Register* connections can be connected in any series or parallel combination desired for information flow in the three registers. Unless otherwise specified, at the time of order, the register connectors will be hooked up in parallel.

SRC-13B – PC-11 Wired for 3 SRE2 and 3 SRD2 and 1 FG-20

The SCR-13B is a PC-11 wired with three additional connectors to accept SRE2 and SRD2 *Strip-Register* units and a connector for an FG-20 Function Generator. A “Write Test Function” switch and “Frequency Select” switch are mounted on the front panel along with a “Fine Frequency” control and sync output jack. Input-output jacks, for the *Strip-Register* memory, using BNC connectors can be made available on the front panel, at no additional cost, if requested at the time

of order. The Three *Strip-Register* connections can be connected in any series or parallel combination desired for information flow in the three registers. Unless otherwise specified, at the time of order, the register connectors will be hooked up in parallel.

SRC-13C – PC-11 Wired for 4 SRE2 and 4 SRD2

The SRC-13C is a PC-11 wired with four additional connectors to accept SRE2 and SRD2 *Strip-Register* units. Input-output jacks, for the *Strip-Register* memory, using BNC connectors can be made available on the front panel, at no additional cost, if requested at the time of order. The four *Strip-Register* connections can be connected in any series or parallel combination desired for information flow in the four registers. Unless otherwise specified, at the time of order, the register connectors will be hooked up in parallel.

SRC-13D – PC-11 Wired for 4 SRE2 and 4 SRD2 and 1 FG-20

The SRC-13D is a PC-11 wired with four additional connectors to accept SRE2 and SRD2 *Strip-Register* units and a connector for an FG-20 Function Generator. A "Write Test Function" switch and "Frequency Select" switch are mounted on the front panel along with a "Fine Frequency" control and sync output jack. Input-output jacks, for the *Strip-Register* memory, using BNC connectors can be made available on the front panel, at no additional cost, if requested at the time of order. The four *Strip-Register* connections can be connected in any series or parallel combination desired for information flow in the three registers. Unless otherwise specified, at the time of order, the register connectors will be hooked up in parallel.

POTTED ELECTRONIC MODULES

SL20-1 – Shift Logic Module

The SL20-1 is a part of the logic electronics required to operate a standard *Strip-Register* device. It contains a clock inverter and shaping circuit as well as the write pulse width one-shot multivibrator.

SL20-2 – Shift Logic Module

The SL20-2 is a part of the logic electronics required to operate a standard *Shift-Register* device. It contains a "Mod. Four" counter for the logic.

SL20-3 – Shift Logic Module

The SL20-3 is a part of the logic electronics required to operate a standard *Strip-Register* device. It contains the propagation pulse width one-shot and the read strobe delay one-shot multivibrator.

SL20-4 – Shift Logic Module

The SL20-4 is a part of the logic electronics required to operate a standard *Strip-Register* device. It contains eight three term "and" gates used in the logic.

PD-20 – Propagation Driver

The PD-20 is a bipolar propagation drive module. It requires a positive gate to operate it and can provide both a positive and negative current pulse of a maximum of 1.2 amps. Two of these modules are required to operate a standard *Strip-Register* device.

WD-20 – Write Driver

The WD-20 is a write driver and provides four separate write drive pulses. It requires a positive gate input and can provide a drive current of up to 800 ma.

RA20-1 – Differential Read Amplifier

The RA20-1 is a pair of high gain differential input amplifiers for use on a single *Strip-Register* device. It has a voltage gain of approximately 10,000 as well as high common mode noise rejection.

RA20-2 – Read Amplifier Mixer, Detector and Output Flip-Flop

The RA20-2 is a module designed to be used in conjunction with the RA20-1. It consists of a mixer, threshold detector and an output flip-flop to provide an NRZ or RZ output.



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PRICE LIST*
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STRIP-REGISTER MEMORY CARDS		Quantity					
		1-4	5-9	10-24	25-49	50-99	100 up
SRU2 Memory Device and Electronics	348 Bits	\$895	\$825	\$770	\$740	\$695	\$650
	xxx Bits	\$945	\$850	\$790	\$750	\$700	\$650
SRU3 Memory Device and Electronics (Cards Only)	348 Bits	\$790	\$725	\$675	\$650	\$610	\$570
	xxx Bits	\$840	\$750	\$695	\$660	\$615	\$570
SRD2 Memory Device and Read Amplifier	348 Bits	\$475	\$425	\$380	\$360	\$325	\$310
	xxx Bits	\$525	\$450	\$400	\$370	\$330	\$310

STRIP-REGISTER ELECTRONIC CARDS		Quantity		
		1-4	5-9	10-24
SRE2 Electronics Only Without Read Amplifiers.....		\$496	\$450	\$429
FG-20 Function Generator		\$194	\$176	\$161

SPECIAL SERVICE CARDS AND CAGE		Quantity 1-4
XC-10 Extender Card		\$35
BC-10 Blank Card 4.5" x 6" with connector		\$19
CC-10 Card Cage		\$65
EC-10 Socket Connector for BLI Cards.....		\$ 8

*Purchase Orders subject to acceptance by IEC in Anaheim; prior to acceptance, prices may be changed without notice.

POTTED ELECTRONIC MODULES (Replacement use only)

		Quantity		
		1-4	5-9	10-24
SL20-1	Shift Logic Module.....	\$ 58.00	\$ 52.90	\$ 51.10
SL20-2	Shift Logic Module.....	\$ 91.10	\$ 83.20	\$ 80.90
SL20-3	Shift Logic Module.....	\$ 90.80	\$ 82.90	\$ 80.70
SL20-4	Shift Logic Module.....	\$ 56.50	\$ 51.60	\$ 50.00
PD20	STRIP-REGISTER Propagation Driver	\$ 99.20	\$ 90.70	\$ 88.30
WD20	STRIP-REGISTER Write Driver.....	\$ 66.20	\$ 62.80	\$ 58.50
RA20-1	Differential Read Amplifier.....	\$148.60	\$140.20	\$130.50
RA20-2	Read Amplifier Mixer, Detector and Output Flip-Flop.....	\$116.00	\$109.50	\$100.90

POWERED CARD CAGES

		Quantity 1-4
PC-10	Powered Card Cage.....	\$ 389.00
PC-11	Powered Card Cage.....	743.00
SRC-10A	PC-10 Wired for 1 SRU2.....	450.00
SRC-10B	PC-10 Wired for 1 SRU2 and 1 FG-20	539.00
SRC-10C	PC-10 Wired for 2 SRU2.....	495.00
SRC-10D	PC-10 Wired for 2 SRU2 and 1 FG-20.....	584.00
SCR-11A	PC-11 Wired for 3 SRU2.....	580.00
SRC-11B	PC-11 Wired for 3 SRU2 and 1 FG-20.....	969.00
SRC-11C	PC-11 Wired for 4 SRU2.....	926.00
SRC-11D	PC-11 Wired for 4 SRU2 and 1 FG-20.....	1015.00
SRC-12A	PC-10 Wired for 1 SRE2 and 1 SRD2.....	492.00
SRC-12B	PC-10 Wired for 1 SRE2 and 1 SRD2 and 1 FG-20.....	581.00
SRC-12C	PC-10 Wired for 2 SRE2 and 2 SRD2.....	579.00
SRC-12D	PC-10 Wired for 2 SRE2 and 2 SRD2 and 1 FG-20.....	668.00
SRC-13A	PC-11 Wired for 3 SRE2 and 3 SRD2.....	1006.00
SRC-13B	PC-11 Wired for 3 SRE2 and 3 SRD2 and 1 FG-20.....	1095.00
SRC-13C	PC-11 Wired for 4 SRE2 and 4 SRD2.....	1095.00
SRC-13D	PC-11 Wired for 4 SRE2 and 4 SRD2 and 1 FG-20.....	1183.00

POWER SUPPLIES

		Quantity 1-4
PS-20	Power supply, 12" x 3" x 4 7/8", provide 2 amp ±10 Vdc regulated and ±18 Vdc unregulated bias voltages.....	\$ 450.00
PS-21	Power supply, 19" rack mount, 6.5 amp ±10 Vdc regulated and ±18 Vdc unregulated bias voltages.....	\$ 810.00
PS-22	Power supply, 19" rack mount, 12 amp ±10 Vdc regulated and ±18 Vdc unregulated bias voltages.....	\$1060.00



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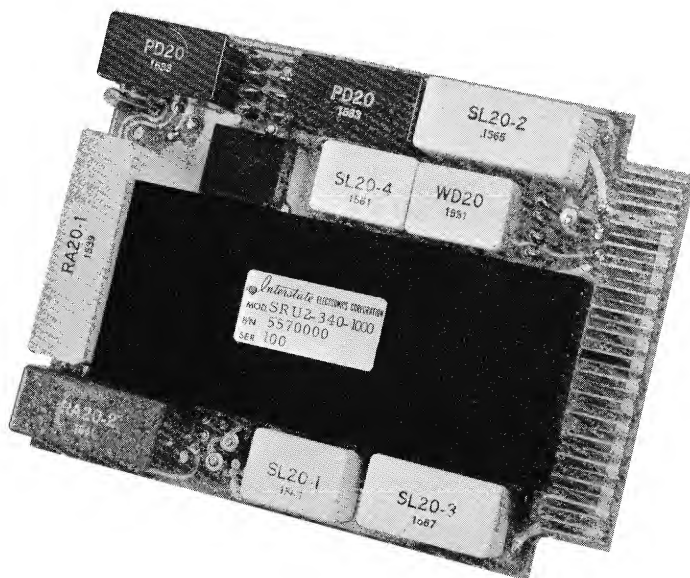
THIN FILM LABORATORY

LOW COST THIN-FILM SHIFT REGISTER

348 Shift Register Bits
Per Module

Asynchronous
Operates Any Speed
From 0 to 1,000,000
Bits Per Second

Thin Magnetic Film
*Strip-Register**
Memory



Non-Volatile

Self Contained
Memory and Electronics
on 4.5" x 6" Plug-In Module

Custom Configurations
Available for Special
Applications with Higher
Speed and for Storage
Capacity

MODEL SRU2

GENERAL CHARACTERISTICS OF SRU2

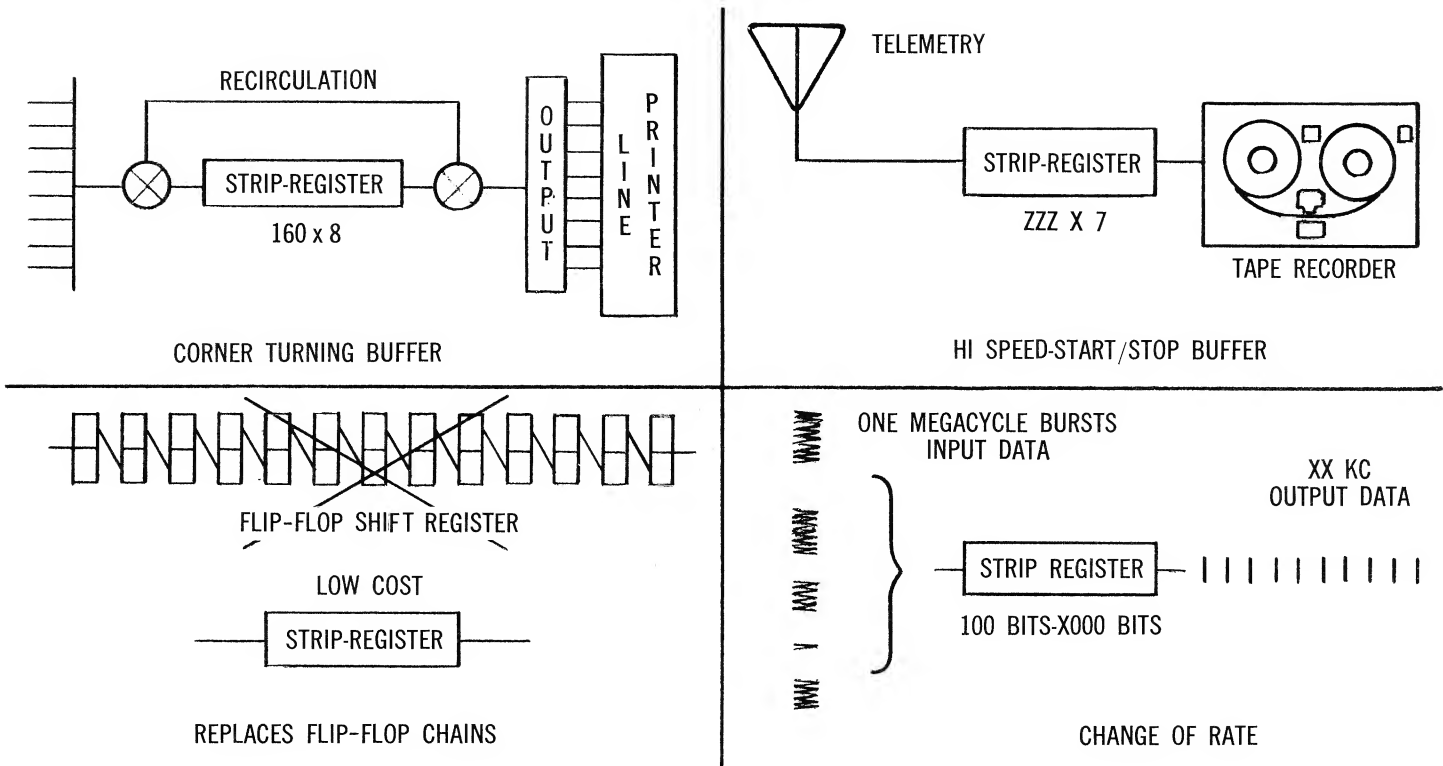
Maximum Serial Readout Rate.....	1,000,000 bits/sec
Maximum Shift Trigger (clock).....	1,000,000 cycles/sec
Input/Output Configuration.....	Serial
Input/Output Levels.....	0 and +8 volts
Storage Capacity Per Card.....	May be ordered in any length up to 348 bits (Special models available over 2000 bits)
Operating Temperature Range.....	-25° C to +75° C
Power supplies and exercise circuitry are available for use with <i>Strip-Register</i> Units	

APPLICATIONS

- Buffers Involving Changes In Information Rates, Hi Speed In - Low Out
- Re-Circulating Information Loops 100 x 1, 128 x 5, ZZZ x 7
- Replacing Flip-Flop, Core-Diode, Core-Transistor Chains
- Start, Stop - Store Applications Telemetry-Tape Buffer
- Memory For Serial Arithmetic Processors Replaces Delay Lines
- Input/Output Buffers For Mass Memory Systems
- Tape, Display, Plotters
- Custom Buffer Configurations For: Card Punches, Card Readers, Line Printers
- Tape Gapping • Tape To Tape • Man/Machine-Computer Interfaces
- 30-Day Delivery Of Systems From Standard Modules

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APPLICATIONS



The Strip-Register

The heart of the SRU2 is a vacuum deposited thin magnetic film *Strip-Register*. This register stores digital information in the form of magnetic domains within a continuous thin magnetic film strip in the manner information is stored within a magnetic drum or tape surface. In contrast to drum and tape surfaces, these techniques allow domains or bits of information to be shifted or translated through the magnetic material without involving any motion of the storage surface. This most unusual operation may be pictured as that of a static magnetic drum storage surface in which the bits of information are caused to flow along or through the surface rather than being moved along by moving the drum surface itself. The elimination of moving parts and inertial restrictions provides striking advantages for the thin-film system.

The operation should not be confused with that of fixed velocity delay lines. The *Strip-Register* is a true asynchronous shift register and its information may be shifted at any periodic or random rate ranging from zero to one megacycle, stepped incrementally or reversed.

 **ELECTRONICS CORPORATION**

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THIN FILM LABORATORY

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